Amendments to the Drawings

Please find 8 pages of formal drawings attached to Appendix A of this paper. No new matter was entered in replacing the drawings.

REMARKS

1. The Application was filed with 52 claims, of which all are restricted except Claims 1, 4, 10-20 and 22-42. Claims 5-9, 21, 37 and 43-52 have been withdrawn from consideration, and have been so marked in the claim listing above. Claims 2-3 are not mentioned in the present Office Action, and Applicants assume they have been withdrawn per the previous restriction requirement. The Examiner is respectfully requested to confirm this assumption. Claim 32 has been amended to correct a typographical error; support for the amendment is found in Claim 14 as filed.

2. Applicants have prepared new drawings per the Examiner's objections. Eight pages of the drawings are attached at Appendix A. No new matter was entered in preparing the formal drawings.

3. The Examiner is thanked for the telephone interview granted on August 24, 2005. Claim 1 was discussed. The undersigned stated that the Hamada reference did not disclose all the limitations of the claim, especially the limitations wherein the device functions as a material with a graded index of refraction, and in which there is a first material and a plurality of discrete structures made of a second material, each of the discrete structures having a size in at least one dimension substantially smaller than an effective wavelength of light in the second material, wherein the size of the discrete structures is different in a first local region than in a second local region. The Examiner instructed Applicants to send in any desired response and amendment, and that the Examiner would re-consider the claims. Agreement on the claims was not reached.

4. Claims 1, 4, 10-20, 28-36, and 38 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Pat. No. 6,798,960, to Hidenobu Hamada ("Hamada"). The rejection states that Hamada anticipates the claims of the application. Office Action, p. 3, lines 16, to p. 4, line 5, citing several portions of Hamada. Applicants traverse the rejections. Hamada indeed teaches several features as described above, but Hamada does not teach combining the features in way to produce a light transmitting device having a graded index of refraction (GRIN). Hamada also does not teach several other limitations of the claims.

Hamada does not teach that the size of the discrete structures is different in a first local region of the body than in a second local region of the body.

As to Claim 1, the rejection cites a first embodiment from Hamada, the first embodiment having a base material, such as $LiNbO_3$, and the second material being Faraday crystals, made of an electro-optic crystal, such as garnet crystals. Col. 16, lines 50-51. The rejection does not state, and Hamada does not teach, that the size of the discrete structures (in this case Faraday crystals) is different in a first local region of the body than in a second local region of the body. It is this difference that provides embodiments of the present invention with the graded index of refraction properties discussed in the application and also discussed below.

In the second embodiment cited in the rejection, there is a base material and a second material, small particulates of high refractive index. Again, there is no teaching that the small particles have a size in a first local region of the base material and a different size in a different local region of the base material. Thus, Hamada does not teach this limitation.

Hamada does not teach a GRIN structure

In a two-dimensional system, Applicants have defined a graded index of refraction (GRIN) property as one in which the effective index of refraction,

$$n_{eff} = \frac{n_1 L_1 + n_2 L_2}{L_1 + L_2},$$ where n_1 and n_2 are the refractive indexes of the two materials respectively, and L_1 and L_2, are the total thickness of the respective materials within a local region larger than the effective wavelength of the light. See specification, p. 12. This can be generalized to three-dimensional system having a medium with a mixture of two particles with different refractive indices, in which

$$n_{\text{eff}} = \frac{n_2\left[\frac{V_1}{V_2}\frac{n_1}{n_2} + 1\right]}{\left[\frac{V_1}{V_2} + 1\right]},$$

in which V_1 and V_2 are the volumes of the first and second materials. Other layers in medium 200 are made of the same materials, but with different thicknesses L_1 and L_2, thereby providing different n_{eff}. See also specification, p. 12. While not limiting

the application in any way, GRIN materials according to the present invention have, as recited in Claim 1, a plurality of layers of the two materials. The materials are combined in the manner described in the application so that they have graded index of refractive properties with an effective index of refraction as taught above.

Hamada teaches the use of discrete structures, such as Faraday columns, see col. 6, lines 38-50, or structures, the refractive particles, col. 13, lines 1-7, but there is no teaching that the Faraday columns and the surrounding material form a graded index of refraction. Indeed, the only comment is that the two materials do have different indices of refraction. However, there is no teaching that the particles and the surrounding material form a material having a graded index of refraction.

Accordingly, Hamada does not anticipate the limitations of Claim 1 and dependent Claim 4 because Hamada does not teach that the size of the discrete structures is different in a first local region from their size in a second local region.

Claims 10-20

Hamada also does not anticipate the limitations of Claim 10, which recites a plurality of layers of a first material and a second material. The Office Action indirectly cites Fig. 23, with its alternating layers of high and low dielectric films, explained as the fifteenth embodiment in cols. 31-32. Fig. 20 is helpful in interpreting Fig. 23. While these passages teach alternating layers of films 131,132, they do not teach that a graded index of refraction material is formed. For instance, as seen in Figs. 20 and 23, the direction of light is transverse to films 106, 107, and thus also films 131, 132. As stated in col. 32, lines 43-46, the films function as a photonic band gap (PBG) reflector with respect to the incident transverse light. A photonic band gap, of course, forbids transmission of light of certain wavelengths.

This property is quite different from, and contradictory to, the claimed graded index of refraction along a direction transverse to the layers. Hamada also does not teach the Claim 10 limitation of forming a light transmitting medium that depends on a local ratio of a volume of the layers of the first material to a volume of the layers of the second material. Rather, Hamada teaches merely that the sum of the individual high-refractive index layer and the low-refractive index layer becomes one-quarter the wavelength of the incident light. Col. 32, lines 57-62.

In addition, the Office Action does not cite, and Hamada does not teach, many limitations of the dependent claims. For example, there is no teaching of the limitations of Claims 11 and 13 that the thickness of each layer of the second material is less than one-tenth the effective wavelength of light in the second material. There is no teaching in Hamada that the thickness of each layer is controlled within 0.5 nm and that the effective index of refraction is controlled to within 0.005, as recited in Claim 14. In any case, Claim 10 is allowable because Hamada does not teach all the limitations of Claim 10. Claims 11-20 are allowable at least because they depend from allowable Claim 10.

Claims 28-36 and 38

By the same reasoning used above for Claims 1 and 10, Hamada also does not teach the Claim 28 limitation that the alternating layers form a graded index of refraction along a direction transverse to the layers. Hamada also does not teach varying the thickness of the layers, nor does Hamada teach that an effective index of refraction (as discussed in the application and above) is formed that depends on a local ratio of a volume of the layers of the first amorphous material to a volume of the layers of the second amorphous material. Claim 28 is thus allowable because Hamada does not teach these limitations recited in Claim 28.

Hamada also does not teach the limitations of many of the dependent claims, such as the Claim 29 limitation that the thickness of each layer of the second material is less than one tenth the effective wavelength of light in the second material. As another example, Hamada does not teach the Claim 32 limitation that the thickness of each layer is controlled to within 0.5 nm and the effective index of refraction is controlled to within 0.005, nor does Hamada teach the Claim 38 limitation that the graded index of refraction is a parabolic function of position along the direction transverse to the layers.

Thus, Claim 28 is allowable, and Claims 29-36 and 38 are allowable at least because they depend from Claim 26. The Examiner is respectfully requested to withdraw the rejections of Claims 28-36 and 38.

5. Claims 21-27 and 39-42 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 6,798,960, to Hidenobu Hamada ("Hamada"), in view of U.S. Pat. Appl. Publ. 2003/0031443 to Marin Soljacic ("Soljacic"). The rejection admits that Hamada does not teach converting mode size from a coupled optical fiber and does not teach converting a small mode size of less than 1 micrometer, but that Soljacic does so teach, citing paragraph [0222]. The rejection also states that since Hamada and Soljacic are from the same field of endeavor, the purpose disclosed by Soljacic would have been recognized in the pertinent art of Hamada. Office Action, p. 5, lines 6-7.

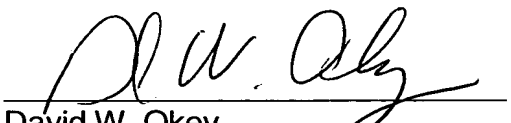
Applicants traverse the rejection. In order to make out a prima facie rejection, there must be some suggestion to combine the references in the references themselves or in the knowledge generally available to those of skill in the art. The rejection supplies no such suggestion, and thus fails to make out a prima facie rejection. Soljacic is directed to high-index contrast fiber waveguides, while Hamada is direction to methods of making a photonic crystal so that the transmission of light may be turned on or off. Light may be the only common thread between them.

In any case, Claims 21-27 depend from Claim 20 and are allowable for at least this reason. The Office Action does not cite, and neither Hamada nor Soljacic teach, many of the limitations of Claims 21-27. For instance, neither teaches the limitation of Claim 22, wherein the graded index of refraction is a parabolic function of position along the direction transverse to the layers, nor the limitation of Claims 23 and 25 that the device has a length such that light having a large mode size entering at a first end of the device and propagating longitudinally through the device is focused to a small mode size at a <u>focal point outside a second end of the device</u> (emphasis added). Neither reference also teaches the Claim 27 limitation that the effective index of refraction varies such that a mode profile of light propagating through the device is transformed from a first mode profile substantially matching a mode profile for light propagating in a single mode fiber to a second mode profile substantially matching a mode profile for light propagating in a semiconductor waveguide. Accordingly, Claims 21-27 are allowable.

Claims 39-42, depending from Claim 28, or on claims depending from Claim 28, are allowable for at least this reason. In addition, neither reference teaches many limitations of Claims 39-42, which are similar to those of Claims 23 and 27. Accordingly, Claims 39-42 are also allowable.

6. Applicants have amended Claim 32 to correct a typographical error. The claims of the present application are not anticipated by Hamada and are not obvious in view of Hamada and Soljacic. Accordingly, Applicants submit that Claims 1, 4, 10-20, and 22-42 are allowable over the prior art of record. The Examiner is asked to withdraw the rejections and to allow the claims of the application. The Examiner is respectfully requested to call the undersigned if the call would help expedite the case or would be helpful to the Examiner.

Respectfully submitted,



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APPENDIX A